AIR QUALITY MONITORING CONSIDERATIONS FOR THE HEARTLAND NETWORK

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Introduction

The NPS Air Resources Division (ARD) has contracted with the University of Denver (DU) to produce GIS-based maps that estimate baseline values (with confidence limits) for a set of air quality parameters for all Inventory and Monitoring parks in the U.S. This information will be available in late FY 2001. ARD will use the DU products to help determine where to expand the existing NPS air quality monitoring network. In the meantime, the Heartland Network can use the on-site and/or nearby off-site ambient monitoring and natural resource data discussed in this report as a guide to conditions and monitoring needs in Network parks.

Wet Deposition

All 15 NPS units in the Heartland Network have at least one National Atmospheric Deposition Program/National Trends Network (NADP) wet deposition monitor within 100 miles. Some units have two or three monitors located in different directions from the park. For those units, because the deposition amounts varied greatly between monitors, data from all monitors within 100 miles of the park were included in this report. Park staff can examine the locations of the monitors relative to the NPS unit, and consider intervening pollution sources and local meteorology, to determine which monitor(s) may best represent conditions in the park.

1984 to 1999 annual wet deposition data were averaged for NADP sites near the Heartland Network parks (Table 1). Years with low data completeness were excluded from the analysis. Deposition amounts ranged from 2.26 to 4.41 kilograms per hectare per year (kg/ha/yr) for ammonium (NH_4), from 6.91 to 15.58 kg/ha/yr for nitrate (NO_3), and from 5.49 to 27.45 kg/ha/yr for sulfate (SO_4). For 1999, in general, wet NH_4 deposition was high in the Heartland Network compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate to high compared to the rest of the U.S. (see maps). Based on a visual (not statistical) analysis of deposition trends from 1984 to 1999, there was either no obvious trend or an increasing trend in wet NH_4 and NO_3 at the NADP monitors near Heartland Network parks, while at all but one site (AR02 near Arkansas Post NMem), there was a decreasing trend in wet SO_4 deposition (Table 2). The decreasing SO_4 trend is consistent with a nationwide decrease in sulfur dioxide emissions mandated by the 1990 amendments to the Clean Air Act.

Based on the proximity of NADP monitors to all units in the Heartland Network, current wet deposition monitoring may be adequate for the Network. However, if results from the DU project indicate high uncertainty in the baseline values for any park, the Network and ARD may want to install one or more NADP monitors. A NADP wet deposition site costs $5,000 to $8,000 for equipment purchase and installation, and operating costs (including site operation, chemical analysis, and reporting) are about $7,000 per year.

Dry Deposition

Only 8 of the 15 NPS units in the Heartland Network have a Clean Air Status and Trends Network (CASTNet) dry deposition monitor within 150 miles of the park. CASTNet uses different monitoring and reporting techniques than NADP, so the dry deposition amounts are reported as nitrogen (N) and sulfur (S). Also, because CASTNet calculates dry deposition based on measured ambient concentrations and estimated deposition velocities, there is greater uncertainty in the reported values.

For CASTNet sites near Heartland Network parks, the calculated amount of dry deposition as a percentage of total deposition ranged from 17 to 38 percent for N and from 12 to 49 percent for S (1997 to 1999 average) (Table 3). 1989 to 1999 annual average dry deposition for the sites ranged from 1.4 to 3.8 kg/ha/yr for N and from 1.2 to 10.5 kg/ha/yr for S (Table 4). CASTNet has not yet provided a nationwide analysis of annual deposition, so it is not possible to compare dry deposition in the Heartland Network to that monitored in the rest of the U.S. A visual (not statistical) analysis of deposition trends from 1989 to 1999 indicates dry N deposition increased at three of the eight sites, while dry S deposition decreased at four of the eight sites (Table 4).

Based on the proximity, alone, of CASTNet sites, it appears that not all parks in the Heartland Network have representative dry deposition data. If the DU products indicate low confidence in the calculated dry deposition values, the Network and ARD may want to consider collecting dry deposition data in some NPS units. Installation and annual operating costs for a CASTNet site are about $50,000 and $15,000, respectively.

Surface Water Chemistry

The Water Resources Division's *Baseline Water Quality Data Inventory and Analysis* reports were reviewed for 11 of the 15 NPS units in the Heartland Network. In some cases the data were extensive; in other cases they were quite limited. Acid-sensitive surface waters typically have a pH below 6.0 and an acid neutralizing capacity below 100 microequivalents per liter (μeq/l). All the data reviewed indicate surface waters in the parks are well buffered, and so, are not sensitive to acidification from atmospheric deposition. Furthermore, it is not likely any of the park surface waters would eutrophy due to nitrogen deposition. Therefore, unless there is reason to believe that sensitive surface waters were not surveyed in the past, there is no need to monitor surface waters, or aquatic biota, in the Heartland Networks for effects from atmospheric deposition.

Visibility

Visibility-impairing particles and certain gases are monitored in natural areas through the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. Because of the mandates of the Clean Air Act, the IMPROVE program has focused monitoring efforts in Class I air quality areas. Regardless, IMPROVE monitoring provides a regional analysis of visibility, therefore, the data indicate conditions in nearby Class II air quality areas. Until recently, there was only one IMPROVE monitor located within the Heartland Network area. That monitor is in the Upper Buffalo Wilderness Area on the Ozark-St. Francis National Forest in Newton County, Arkansas. IMPROVE sites located on the borders of the Heartland Network can provide some indication of conditions in the Network. Some of these bordering sites are Mammoth Cave NP in Kentucky, Badlands NP in South Dakota, Boundary Waters

Canoe Area on the Superior National Forest in Upper Minnesota, and Dolly Sods Wilderness Area on the Monongahela National Forest in West Virginia.

One measure of visibility impairment is "extinction", which is reported as inverse megameters (-Mm). Extinction is the scattering or absorption of light as it passes through the air. The higher the extinction value, the greater the visibility impairment. 1996 through 1998 IMPROVE data indicated extinction values were much higher in the eastern U.S. than in the western U.S. (see map). Based on data for IMPROVE sites in and around the Heartland Network area, Mammoth Cave NP had the highest total extinction, followed by Dolly Sods Wilderness Area, then Upper Buffalo Wilderness Area, then Boundary Waters Canoe Area, then Badlands NP (see graphs; note differences in scale). Of the five major types of visibility-impairing particles (*i.e.*, sulfate, nitrate, organics, light absorbing carbon, and soil), sulfate was the major contributor to visibility impairment at IMPROVE sites in the eastern U.S. Data from IMPROVE sites are combined, when appropriate, to provide regional visibility information. The 1996 through 1998 regional data showed higher extinction values in the eastern U.S. than in the western U.S. (Figure S.8). Another measure of visibility impairment, standard visual range, indicates how far a large object (*e.g.*, a mountain) can be seen in the distance. 1996 through 1998 IMPROVE data showed annual average standard visual range numbers were much lower in the eastern U.S. (28 to 90 km) than in the western U.S. (86 to 175 km) (see map).

As part of the Regional Haze regulations recently issued by the U.S. Environmental Protection Agency, a number of sites are being added to the IMPROVE network over the next few years. Seven sites have been, or will be, added in the Heartland Network area--the M.K. Goddard site on the western Pennsylvania border (exact location unknown); Quaker City, Ohio; Livonia, Indiana; Bondville, Illinois; Mingo National Wildlife Refuge in southeastern Missouri; Hercules-Glades Wilderness Area on the Mark Twain National Forest in Taney County, Missouri; and the Caney Creek Wilderness Area on the Ouachita National Forest in Polk County, Arkansas. With the expansion of the IMPROVE network, all but six of the Heartland Network parks will have a monitor within 100 miles (see map). If the DU products indicate high uncertainty in the visibility values for some Heartland Network parks, the Network and ARD may want to consider doing some type of visibility monitoring in the parks. Installation and annual operating costs of an IMPROVE site are about $15,000 and $30,000, respectively.

Ozone

Ozone monitors are located within 70 miles of all Heartland Network parks. In some cases, the closest monitor for a rural park is in an urban area, so the data may not be very representative of ozone concentrations in the park. Pending the results of the DU project, it is not possible to determine the adequacy of existing monitors to represent ozone conditions in units of the Heartland Network. The Network or ARD may need to monitor ozone in some park units. Installation and annual operating costs for an ozone-monitoring site are about $25,000 and $28,000, respectively.

It is generally agreed that plant foliar injury occurs after a cumulative exposure to ozone. One ozone statistic that is used to evaluate the risk of plant injury is the SUM06. SUM06 is

the sum of all hourly average ozone concentrations greater than or equal to 0.06 parts per million (ppm). In 1997, a group of ozone effects experts recommended 3-month, 8:00 a.m. to 8:00 p.m., SUM06 effects endpoints for natural vegetation, *i.e.*, 8 to12 ppm-hrs for foliar injury to natural ecosystems and 10 to 15 ppm-hrs for growth effects on tree seedlings in natural forest stands. The DU products will give an indication of the ozone risk to sensitive vegetation in Heartland Network parks.

Vegetation

The focus is on ozone sensitivity for vegetation because 1) ozone is a regional pollutant and is, therefore, more likely to affect park resources than either sulfur dioxide or nitrogen oxide which quickly convert to other compounds, and 2) the literature on ozone sensitivity is more recent and more reliable than that for other pollutants. Fortunately, a great deal is known about the ozone sensitivity of eastern U.S. species. Park vascular plant lists contained in the January 22, 2001, version of NPSpecies were compared to the general ozone-sensitive plant species lists contained in the NPS Synthesis information management system (see Synthesis species lists). The Synthesis lists were developed by an expert in the field of ozone effects on vegetation. Note that the Synthesis lists are a general guide to ozone sensitivity. Differences in plant genetics, weather conditions, and ozone concentrations will affect whether or not a species exhibits injury in a particular park.

A number of potentially ozone-sensitive species were identified in each of the Heartland Network parks. All parks have either black cherry (*Prunus serotina*) or milkweed species (*Asclepias* spp.), both of which are good candidates for foliar injury surveys because ozone injury on these species is well documented. Park staff can easily be trained to identify and evaluate ozone-induced foliar injury on vegetation. Moreover, surveys for foliar injury could be combined with other types of vegetation surveys needed in the Heartland Network.

Conclusions

All units of the Heartland Network have at least one NADP wet deposition monitor within 100 miles.

Eight of the 15 Heartland Network parks have a CASTNet dry deposition monitor within 150 miles. The seven units that do not have a nearby dry deposition monitor are: Buffalo NR, George Washington Carver NM, Homestead NM of America, Pea Ridge NMP, Pipestone NM, Tallgrass Prairie NPres, and Wilson's Creek NB.

11 of the Heartland Network parks have a *Baseline Water Quality Data Inventory and Analysis* report. Those units that don't have a report include Effigy Mounds NM, George Washington Carver NM, Hopewell Culture NHP, and Wilson's Creek NB. All existing data indicate surface waters in the Heartland Network are not sensitive to atmospheric deposition.

Nine of the 15 units of the Heartland Network have an IMPROVE visibility monitor within 100 miles. The six units that do not have a nearby IMPROVE monitor are: Arkansas Post NMem, Effigy Mounds NM, Herbert Hoover NHS, Homestead NM of America, Pipestone NM, and Tallgrass Prairie NPres.

All Heartland Network parks have at least one ozone monitor within 70 miles.

All Heartland Network parks have one or more vascular plant species that are good biomonitors for ozone-induced foliar injury, *i.e*., black cherry and milkweed species.

Relevant Websites

NADP - http://nadp.sws.uiuc.edu/
CASTNet - http://www.epa.gov/castnet/
Ozone - http://www.epa.gov/airsdata/sources.htm
IMPROVE - http://vista.cira.colostate.edu/improve/
Pollution sources and air quality data - http://www.epa.gov/airsdata/
Pollution sources and air quality data - http://www.epa.gov/ttn/rto/areas/
Pollution sources and air quality data - http://www.epa.gov/agweb/

ARKANSAS POST NMem

- Wet deposition has been monitored at the NADP site at Warren, Arkansas (AR02), 50 miles SW of the park, since 1982. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 3.28, 10.62, and 15.22 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate compared to the rest of the U.S. A visual analysis indicated no obvious trends in pollutant deposition for 1984 through 1999.

- Dry deposition has been monitored at the CASTNet site at Coffeeville, Mississippi (CVL151), 90 miles E of the park, since 1988. Based on 1997 through 1999 data, dry N accounted for 31 percent of total N deposition, while dry S accounted for 23 percent of total S deposition. For 1989 through 1999, annual average dry N deposition at the Coffeeville site was 2.0 kg/ha/yr, and annual average dry S deposition was 1.7 kg/ha/yr. A visual analysis of the 1989 through 1999 CASTNet data indicated dry N deposition was increasing, but there was no apparent trend in dry S deposition.

- A review of the 1997 *Baseline Water Quality Data Inventory and Analysis* report for Arkansas Post NMem indicated no water chemistry data have been collected within the park. However, it appears that the park is bordered on three sides by the Arkansas River, and that all park waters connect to the river. Water samples collected between 1972 and 1994 indicated a mean pH of about 7.8, and a mean acid neutralizing capacity of 600 microequivalents per liter (μeq/l). These data show the Arkansas River is not sensitive to acid deposition. Additional data collection was initiated in the park in 2000.

- There are no IMPROVE visibility monitors existing, or planned, within 100 miles of the park.

- The closest ozone monitor is located 40 miles SE of the park in Cleveland, Mississippi (#280110001). By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the park vascular plant list contained in NPSpecies, nine species occur in the park that are known to be very sensitive to ozone and four species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the park is black cherry because the symptoms of ozone injury are well documented on that species.

BUFFALO NR

- Wet deposition has been monitored on-site at the NADP site at Cozahome, Arkansas (AR16), since 1982. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 2.26, 9.23, and 12.28 kg/ha/yr, respectively. For 1999, wet NH_4, NO_3, and SO_4 deposition were moderate compared to the rest of the U.S. A visual analysis indicated no obvious trends in wet NH_4 and NO_3 deposition for 1984 through 1999, and a decreasing trend in wet SO_4 deposition.

- There are no CASTNet dry deposition monitoring sites within 150 miles of Buffalo NR.

- A review of the 1997 *Baseline Water Quality Data Inventory and Analysis* report for Buffalo NR indicated many water chemistry data have been collected in the river, creeks, and springs within the park. Samples collected at various locations along the Buffalo River between 1986 and 1996 indicated a mean pH of 8.0 and an acid neutralizing capacity (ANC) of 200-1,100 microequivalents per liter (μeq/l). Samples collected at creeks (*e.g.*, Middle and Leatherwood) also had a pH of about 8.0, with an ANC of 900-1,500 μeq/l. Springs such as Gilbert, Mitch Hill, and Luallen had a pH of about 7.4, with an ANC of 1,000-1,600 μeq/l. These data indicate surface waters in Buffalo NR are not sensitive to acid deposition.

- An IMPROVE visibility monitor (UPBU) has been operating within 100 miles south of the park, at the Upper Buffalo Wilderness Area on the Ozark-St. Francis National Forest in Newton County, Arkansas, since 1991. Based on 1996 through 1998 data, visibility at the site was best in December and January and worst in June through September. The majority of the impairment in all months was due to sulfate, followed by nitrate in November through March or organics in April through October. After data collection in 2001, the UPBU site will have been operating long enough to include the data in a networkwide trends analysis.

- The closest ozone monitor is located in Newton County, Arkansas (#051010002) (exact location unknown). By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the park vascular plant list contained in NPSpecies, 14 species occur in the park that are known to be very sensitive to ozone and 14 species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the park is black cherry because the symptoms of ozone injury are well documented on that species. Another good indicator of ozone injury is milkweed.

CUYAHOGA VALLEY NP

- Wet deposition has been monitored at the NADP site at Wooster, Ohio (OH71), 30 miles SW of the park, since 1978. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 3.41, 15.58, and 25.12 kg/ha/yr, respectively. For 1999, wet pollutant deposition was moderate compared to the rest of the U.S. A visual analysis indicated no obvious trends in wet NH_4 or NO_3 deposition, and a decreasing trend in SO_4 deposition, for 1984 through 1999.

- Dry deposition has been monitored at the CASTNet site at Ann Arbor, Michigan (ANA115), 120 miles NW of the park, since 1988. Based on 1997 through 1999 data, dry N accounted for 28 percent of total N deposition, while dry S accounted for 34 percent of total S deposition. For 1989 through 1999, annual average dry N deposition at the Ann Arbor site was 2.4 kg/ha/yr, and annual average dry S deposition was 3.5 kg/ha/yr. A visual analysis of the 1989 through 1999 CASTNet data indicated no obvious trend in dry N deposition, and a decreasing trend in dry S deposition.

- A review of the 1995 *Baseline Water Quality Data Inventory and Analysis* report for Cuyahoga Valley NP indicated many lakes, creek, and rivers within the park were sampled from the early 1970s to the mid-1990s. The Cuyahoga River had a mean pH of 8.0, with a mean acid neutralizing capacity (ANC) of 1,800 microequivalents per liter (μeq/l). Lakes such as Summit, Wing, and Springfield had a pH of 8.0, with an ANC of 1,100-2,500 μeq/l. Creeks (*e.g.*, Brandywine and Sagamore) had a mean pH of 8.0, and a mean ANC of 1,200 μeq/l. These data indicate surface waters in Cuyahoga Valley NP are not sensitive to acid deposition.

- A new IMPROVE visibility monitoring site has been, or soon will be, installed within 100 miles east of the park. The IMPROVE site (MKGO) will be on the western Pennsylvania border (exact location unknown).

- Two ozone monitors are located near the park. One is in Akron, Ohio (#391530020), about 10 miles S of the park. The other is located in Cleveland, Ohio (#390350034), about 15 miles N of the park. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the vascular plant list for the park contained in NPSpecies, 22 species occur in the park that are known to be very sensitive to ozone and 13 species occur that are known to be slightly sensitive to ozone. Good choices for ozone injury surveys in the park are black cherry and quaking aspen because the symptoms of ozone injury are well documented on those species. Milkweed species are also good indicators of ozone injury.

EFFIGY MOUNDS NM

- Wet deposition has been monitored at the NADP site at the Big Springs Fish Hatchery, Iowa (IA08), 20 miles SW of the monument, since 1984. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 4.41, 12.59, and 14.14 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate. A visual analysis indicated increasing trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999.

- Dry deposition has been monitored at the CASTNet site at Stockton, Illinois (STK138), 90 miles NW of the monument, since 1993. Based on 1997 through 1999 data, dry N accounted for 19 percent of total N deposition, while dry S accounted for 31 percent of total S deposition. For 1989 through 1999, annual average dry N deposition at the Stockton site was 2.0 kg/ha/yr, and annual average dry S deposition was 3.5 kg/ha/yr. A visual analysis indicated an increasing trend in dry N deposition for 1989 through 1999, and no obvious trend in dry S deposition.

- Water chemistry data were not available for Effigy Mounds NM. A *Baseline Water Quality Data Inventory and Analysis* report should be completed for the monument in the summer of 2001.

- There are no IMPROVE visibility monitors existing, or planned, within 100 miles of the monument.

- Two ozone monitors are located near the monument. One is in Waverly, Iowa (#190170011), about 70 miles SW of the monument. The other is in Ontario, Wisconsin (#551230008), about 55 miles NE of the monument. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the monument vascular plant list contained in NPSpecies, seven species occur in the monument that are known to be very sensitive to ozone and nine species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the monument is black cherry because the symptoms of ozone injury are well documented on that species. Milkweed species are also good indicators of ozone injury.

GEORGE WASHINGTON CARVER NM

- Wet deposition is monitored at three NADP sites near the monument. The Farlington, Kansas site (KS07), located 50 miles NW of the monument, has been operating since 1984. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition at that site were 3.26, 12.06, and 15.04 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate. A visual analysis indicated increasing trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999 at the Farlington site. The Fayetteville, Arkansas NADP site (AR27), located 55 miles S of the monument, has been operating since 1980. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition at that site were 3.44, 10.48, and 13.35 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate. A visual analysis indicated no trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999 at the Fayetteville site. The Lake Eucha, Oklahoma NADP site (OK08), located 35 miles SW of the monument, began operation in February 2000, so data are not yet available from the site.

- There are no CASTNet dry deposition monitoring sites within 150 miles of George Washington Carver NM.

- Water chemistry data were not available for George Washington Carver NM.

- A new IMPROVE visibility monitoring site has been, or soon will be, installed within 100 miles east of the monument. The IMPROVE site (HEGL) will be in the Hercules-Glades Wilderness Area on the Mark Twain National Forest in Taney County, Missouri.

- Two ozone monitors are located in Springfield, Missouri (#290770026 and #290770036), about 60 miles E of the monument. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the monument vascular plant list contained in NPSpecies, 12 species occur in the monument that are known to be very sensitive to ozone and eight species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the monument is black cherry because the symptoms of ozone injury are well documented on that species.

HERBERT HOOVER NHS

- Wet deposition has been monitored at the NADP site at Monmouth, Illinois (IL78), 55 miles SE of the historic site, since 1985. 1985 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 3.75, 11.72, and 16.16 kg/ha/yr, respectively. For 1999, wet NH_4, NO_3, and SO_4 deposition were high compared to the rest of the U.S. A visual analysis indicated increasing trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1985 through 1999.

- Dry deposition has been monitored at the CASTNet site at Stockton, Illinois (STK138), 100 miles SW of the historic site, since 1993. Based on 1997 through 1999 data, dry N accounted for 19 percent of total N deposition, while dry S accounted for 31 percent of total S deposition. For 1989 through 1999, annual average dry N deposition at the Stockton site was 2.0 kg/ha/yr, and annual average dry S deposition was 3.5 kg/ha/yr. A visual analysis indicated an increasing trend in dry N deposition for 1989 through 1999, and no obvious trend in dry S deposition.

- A review of the 1999 *Baseline Water Quality Data Inventory and Analysis* report for Herbert Hoover NHS indicated a few water chemistry samples were collected in the historic site on the West Branch of Wapsinonoc Creek in 1990 and 1993. The samples had an average pH of 7.7 and a mean acid neutralizing capacity of 2,000 microequivalents per liter. These limited data indicate surface waters in Herbert Hoover NHS are not sensitive to acid deposition.

- There are no IMPROVE visibility monitors existing, or planned, within 100 miles of the historic site.

- The closest ozone monitors are located in Cedar Rapids, Iowa (#191130020, #191130028, and #19113033), which is about 25 miles NW of the historic site. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the vascular plant list for the historic site contained in NPSpecies, nine species occur in the park that are known to be very sensitive to ozone and 11 species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the historic site is black cherry because the symptoms of ozone injury are well documented on that species. Milkweed species are also good indicators of ozone injury.

HOMESTEAD NM OF AMERICA

- Wet deposition has been monitored at two NADP sites near the monument. The Mead, Nebraska site (NE15), located 60 miles N of the monument, has been operating since 1978. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 4.26, 9.98, and 9.95 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate. A visual analysis indicated no obvious trends in wet NH_4 or NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999. The Konza Prairie, Kansas site (KS31), located 70 miles S of the monument, has been operating since 1982. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 3.06, 10.66, and 10.70 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate. A visual analysis indicated an increasing trend in wet NH_4 deposition, no obvious trend in wet NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999.

- There are no CASTNet dry deposition monitoring sites within 150 miles of Homestead NM of America.

- A review of the 1999 *Baseline Water Quality Data Inventory and Analysis* report for Homestead NM of America indicated water chemistry samples were collected in the monument in Cub Creek between 1989 and 1997. The samples had a mean pH value of 7.8, with acid neutralizing capacity ranging from 1,800 to 3,500 microequivalents per liter. These data indicate surface waters in the monument are not sensitive to acid deposition.

- There are no IMPROVE visibility monitors existing, or planned, within 100 miles of the monument.

- The closest ozone monitor is located in Davey, Nebraska (#311090016), about 50 miles N of the monument. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the monument vascular plant list contained in NPSpecies, three species occur in the monument that are known to be very sensitive to ozone and five species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the monument is milkweed because the symptoms of ozone injury are fairly well documented on that species.

HOPEWELL CULTURE NHP

- An NADP wet deposition monitoring site was initiated at Deer Creek State Park, Ohio (OH54), located 20 miles NW of the park, in January 1999. 1999 annual wet deposition data show NH_4, NO_3, and SO_4 deposition were 1.64, 9.88, and 12.19 kg/ha/yr, respectively. For 1999, wet NH_4, NO_3, and SO_4 deposition were high compared to the rest of the U.S. 1989 through 1999 wet deposition data reported by CASTNet for Deer Creek State Park (source of data unknown) showed no obvious trend in NH_4 or NO_3 deposition, and a decreasing trend in SO_4 deposition.

- Dry deposition has been monitored at the CASTNet site at Deer Creek State Park (DCP114) since 1988. Based on 1997 through 1999 data, dry N accounted for 38 percent of total N deposition, while dry S accounted for 49 percent of total S deposition. For 1989 through 1999, annual average dry N deposition at the Deer Creek State Park site was 3.8 kg/ha/yr, and annual average dry S deposition was 7.9 kg/ha/yr. A visual analysis indicated no obvious trend in dry N deposition for 1989 through 1999, and a decreasing trend in dry S deposition.

- Water chemistry data were not available for Hopewell Culture NHP. A *Baseline Water Quality Data Inventory and Analysis* report should be completed for the park this summer.

- A new IMPROVE visibility monitoring site has been, or soon will be, installed within 100 miles northeast of the park. The IMPROVE site (QUCI) will be in Quaker City, Ohio.

- Three ozone monitors are located near the monument. Two monitors are located in Columbus, Ohio (#390490004 and #390490081), about 40 miles N of the monument. A third monitor is located in Wilmington, Ohio (#390271002), about 45 miles W of the monument. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the park vascular plant list contained in NPSpecies, 13 species occur in the park that are known to be very sensitive to ozone and ten species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the park is black cherry because the symptoms of ozone injury are well documented on this species. Milkweed species are also good indicators of ozone injury.

HOT SPRINGS NP

- Wet deposition has been monitored at the NADP site at Caddo Valley, Arkansas (AR03), located 20 miles S of the park, since 1983. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 2.68, 12.14, and 17.33 kg/ha/yr, respectively. For 1999, wet NH_4, NO_3, and SO_4 deposition were high compared to the rest of the U.S. A visual analysis indicated no obvious trends in wet NH_4 or NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999.

- Dry deposition has been monitored at the CASTNet site at Caddo Valley (CAD150) since 1988. Based on 1997 through 1999 data, dry N accounted for 17 percent of total N deposition, while dry S accounted for 12 percent of total S deposition. For 1989 through 1999, annual average dry N deposition at the Caddo Valley site was 1.4 kg/ha/yr, and annual average dry S deposition was 1.2 kg/ha/yr. A visual analysis indicated no obvious trend in dry N or S deposition for 1989 through 1999.

- A review of the 1998 *Baseline Water Quality Data Inventory and Analysis* report for Hot Springs NP indicated a number of water chemistry samples were collected inside and outside the park between 1978 and 1993. Inside the park, samples from Rick's Pond, Hot Springs Creek and Gulpha Creek had a pH of 7.0 or higher and acid neutralizing capacity ranged from 350-1,200 microequivalents per liter. These data indicate surface waters in Hot Springs NP are not sensitive to acid deposition.

- A new IMPROVE visibility monitoring site has been, or soon will be, installed within 100 miles west of the park. The IMPROVE site (CACR) will be in the Caney Creek Wilderness Area on the Ouachita National Forest in Polk County, Arkansas.

- The closest ozone monitor is located west of the park in Montgomery County, Arkansas (#050970001) (exact location unknown). By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the park vascular plant list contained in NPSpecies, 16 species occur in the park that are known to be very sensitive to ozone and 11 species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the park is black cherry because the symptoms of ozone injury are well documented on this species. Milkweed species are also good indicators of ozone injury.

LINCOLN BOYHOOD NM

- Wet deposition has been monitored at the NADP site at Frickton, Indiana (IN22), located 55 miles NW of the monument, since 1984. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 3.28, 14.38, and 27.45 kg/ha/yr, respectively. For 1999, wet NH_4, NO_3, and SO_4 deposition were high compared to the rest of the U.S. A visual analysis indicated increasing trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999.

- Dry deposition has been monitored at the CASTNet site at Vincennes, Indiana (VIN140), located 45 miles NW of the monument, since 1987. Based on 1997 through 1999 data, dry N accounted for 29 percent of total N deposition, while dry S accounted for 49 percent of total S deposition. For 1989 through 1999, annual average dry N deposition at the Vincennes site was 2.9 kg/ha/yr, and annual average dry S deposition was 10.5 kg/ha/yr. A visual analysis indicated no obvious trend in dry N deposition, and a decreasing trend in dry S deposition, for 1989 through 1999.

- A review of the 2000 *Baseline Water Quality Data Inventory and Analysis* report for Lincoln Boyhood NM indicated one observation from a spring outside the park in 1979. The pH of the sample was 8.0. Limited data indicate surface waters in Lincoln Boyhood NM are not sensitive to acid deposition. Additional data collection will soon be initiated in the monument.

- A new IMPROVE visibility monitoring site has been, or soon will be, installed within 100 miles northeast of the monument. The IMPROVE site (LIVO) will be in Livonia, Indiana.

- Two ozone monitors are located near the monument. One is in Boonville, Indiana (#181730008), about 15 miles W of the monument. The other is in Perry County, Indiana (#181230008), about 15 miles NE of the monument. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the monument vascular plant list contained in NPSpecies, nine species occur in the monument that are known to be very sensitive to ozone and 11 species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the monument is black cherry because the symptoms of ozone injury are well documented on this species. Milkweed species are also good indicators of ozone injury.

OZARK NSR

- Wet deposition has been monitored at the NADP site at Wappapello, Missouri (MO05), located 30 miles E of the park, since 1981. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 3.04, 13.22, and 18.99 kg/ha/yr, respectively. For 1999, wet NH_4 and NO_3 deposition were high compared to the rest of the U.S., and wet SO_4 deposition was moderate. A visual analysis indicated an increasing trend in wet NH_4 deposition, no obvious trend in wet NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999.

- Dry deposition has been monitored at the CASTNet site at Alhambra, Illinois (ALH157), located 140 miles NE of Ozark NSR, since 1988. Based on 1997 through 1999 data, dry N accounted for 23 percent of total N deposition, while dry S accounted for 44 percent of total S deposition. For 1989 through 1999, annual average dry N deposition at the Alhambra site was 2.0 kg/ha/yr, and annual average dry S deposition was 6.1 kg/ha/yr. A visual analysis indicated no obvious trend in dry N deposition, and a decreasing trend in dry S deposition, for 1989 through 1999.

- A review of the 1995 *Baseline Water Quality Data Inventory and Analysis* report for Ozark NSR indicated a number of water chemistry samples were collected on the river, creeks and springs in the park between 1973 and 1994. The mean pH of the river was 8.2, and the mean acid neutralizing capacity (ANC) was 1,300 microequivalents per liter (μeq/l). Creeks, such as Shawnee and Rogers, had an average pH of 8.0, and an average ANC of 1,400 μeq/l. Springs (*e.g.*, Big, Round, and Alley) had an average pH of 7.5, and an average ANC of 1,200 μeq/l. These data indicate surface waters in Ozark NSR are not sensitive to acid deposition.

- Two new IMPROVE visibility monitoring sites have been, or soon will be, installed within 100 miles of the park. The first IMPROVE site (MING) will be east of the park in the Mingo National Wildlife Refuge, Missouri. The second IMPROVE site (HEGL) will be southwest of the park in the Hercules-Glades Wilderness Area on the Mark Twain National Forest in Taney County, Missouri.

- The closest ozone monitor is located in Bonne Terre, Missouri, (#291860005) about 60 miles NE of the park. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the park vascular plant list contained in NPSpecies, 12 species occur in the park that are known to be very sensitive to ozone and 10 species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the park is black cherry because the symptoms of ozone injury are well documented on this species. Milkweed species are also good indicators of ozone injury.

PEA RIDGE NMP

- Wet deposition is monitored at two NADP sites near the park. The Fayetteville, Arkansas site (AR27), located 20 miles S of the park, has been operating since 1980. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition at that site were 3.44, 10.48, and 13.35 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate. A visual analysis indicated no trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999. The Lake Eucha, Oklahoma, NADP site (OK08), located 30 miles W of the park, began operation in February 2000, so data are not yet available.

- There are no CASTNet dry deposition monitoring sites within 150 miles of Pea Ridge NMP.

- A review of the 1998 *Baseline Water Quality Data Inventory and Analysis* report for Pea Ridge NMP indicated no water chemistry samples were collected in the park. A review of the park brochure suggests all surface waters in the park are perennial. One water sample was collected in a spring outside the park in 1994. The sample had a pH of 7.6, and acid neutralizing capacity of 1,100 microequivalents per liter. These very limited data indicate surface waters in Pea Ridge NMP are not sensitive to acid deposition. Additional data collection was initiated in the park in 2000.

- An IMPROVE visibility monitor (UPBU) has been operating within 100 miles southeast of the park, at the Upper Buffalo Wilderness Area on the Ozark-St. Francis National Forest in Newton County, Arkansas, since 1991. Based on 1996 through 1998 data, visibility at the site was best in December and January and worst in June through September. The majority of the impairment in all months was due to sulfate, followed by nitrate in November through March or organics in April through October. After data collection in 2001, the UPBU site will have been operating long enough to include the data in a networkwide trends analysis.

- The closest ozone monitor is located in Newton County, Arkansas (#051010002) (exact location unknown). Two additional monitors are located in Springfield, Missouri (#290770026 and #290770036), about 60 miles NE of the park. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the park vascular plant list contained in NPSpecies, 13 species occur in the park that are known to be very sensitive to ozone and eight species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the park is black cherry because the symptoms of ozone injury are well documented on this species.

PIPESTONE NM

- Wet deposition is monitored at two NADP sites near the monument. The Huron, South Dakota site (SD99), located 100 miles NW of the park, has been operating since 1983. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition at that site were 3.25, 6.91, and 5.49 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were low. A visual analysis indicated increasing trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999. The Lamberton, Minnesota site (MN27), located 60 miles NE of the monument, has been operating since 1979. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition at that site were 4.09, 8.75, and 8.02 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were low. A visual analysis indicated no obvious trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999.

- There are no CASTNet dry deposition monitoring sites within 150 miles of Pipestone NM.

- A review of the 1999 *Baseline Water Quality Data Inventory and Analysis* report for Pipestone NM indicated water chemistry samples were collected inside and outside the monument in the 1980s. All samples had a pH of 7.0 to 8.0, and all had high acid neutralizing capacity, with the highest measurement being 1,100 microequivalents per liter. These data indicate surface waters in Pipestone NM are not sensitive to acid deposition.

- There are no IMPROVE visibility monitors existing, or planned, within 100 miles of the monument.

- The closest ozone monitor is located in Sioux Falls, South Dakota (#460990007), about 35 miles SW of the monument. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the monument vascular plant list contained in NPSpecies, six species occur in the monument that are known to be very sensitive to ozone and four species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the monument is milkweed because the symptoms of ozone injury are fairly well documented on milkweed species.

TALLGRASS PRAIRIE NPres

- Wet deposition is monitored at two NADP sites near the preserve. The Konza Prairie, Kansas site (KS31), located 50 miles N of the preserve, has been operating since 1982. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 3.06, 10.66, and 10.70 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate. A visual analysis indicated an increasing trend in wet NH_4 deposition, no obvious trend in wet NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999. The Farlington, Kansas site (KS07), located 100 miles SE of the preserve, has been operating since 1984. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition at that site were 3.26, 12.06, and 15.04 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate. A visual analysis indicated increasing trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999.

- There are no CASTNet dry deposition monitoring sites within 150 miles of Tallgrass Prairie NPres.

- By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- There are no IMPROVE visibility monitors existing, or planned, within 100 miles of the preserve.

- The closest ozone monitor is located in Wichita, Kansas (#201730010), about 50 miles SW of the preserve. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the vascular plant list contained in NPSpecies, five species occur in the preserve that are known to be very sensitive to ozone and nine species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the preserve is milkweed because the symptoms of ozone injury are fairly well documented on milkweed species.

WILSON'S CREEK NB

- Wet deposition is monitored at two NADP sites near the park. The Fayetteville, Arkansas site (AR27), located 80 miles SW of the park, has been operating since 1980. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition at that site were 3.44, 10.48, and 13.35 kg/ha/yr, respectively. For 1999, wet NH_4 deposition was high compared to the rest of the U.S., while wet NO_3 and SO_4 deposition were moderate. A visual analysis indicated no trends in wet NH_4 and NO_3 deposition, and a decreasing trend in wet SO_4 deposition, for 1984 through 1999. The NADP site at Cozahome, Arkansas (AR16), located 90 miles SE of the park, has been operating since 1982. 1984 through 1999 annual average wet NH_4, NO_3, and SO_4 deposition were 2.26, 9.23, and 12.28 kg/ha/yr, respectively. For 1999, wet NH_4, NO_3, and SO_4 deposition were moderate compared to the rest of the U.S. A visual analysis indicated no obvious trends in wet NH_4 and NO_3 deposition for 1984 through 1999, and a decreasing trend in wet SO_4 deposition.

- There are no CASTNet dry deposition monitoring sites within 150 miles of Wilson's Creek NB.

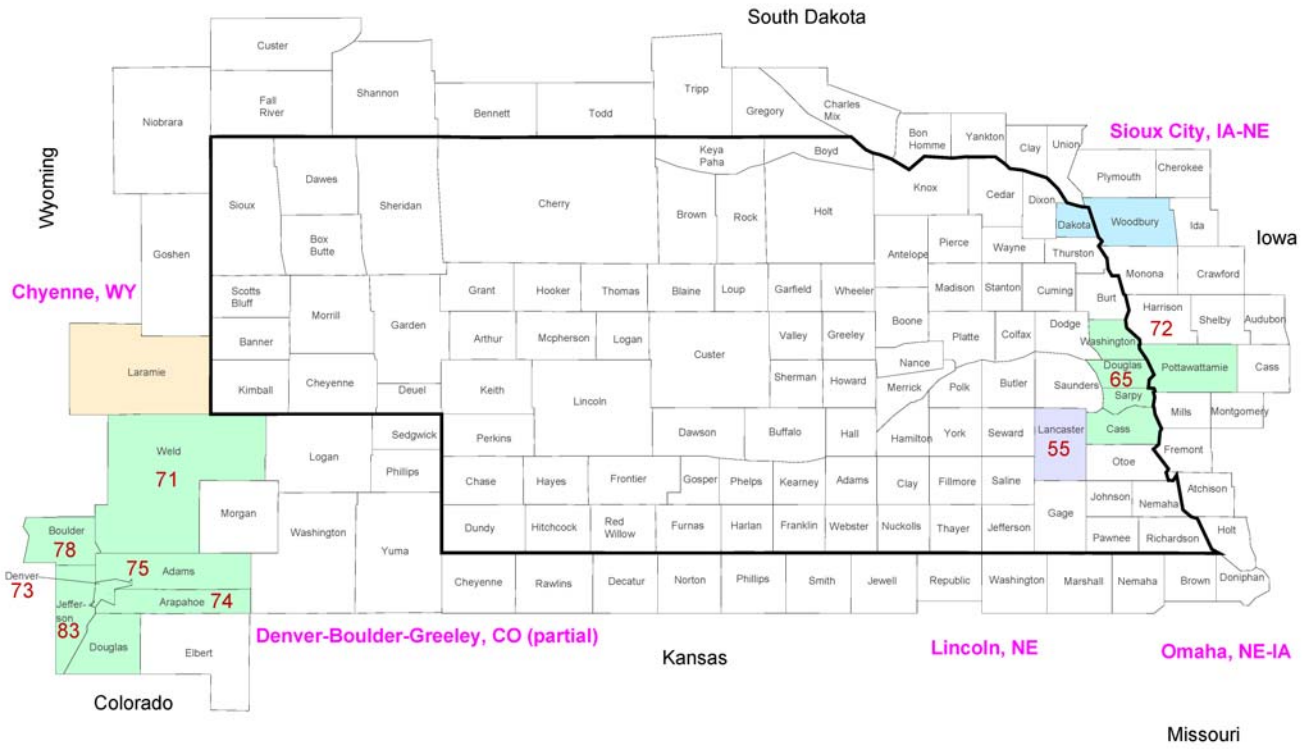
- Water chemistry data were not available for Wilson's Creek NB.

- A new IMPROVE visibility monitoring site has been, or soon will be, installed within 100 miles southeast of the park. The IMPROVE site (HEGL) will be in the Hercules-Glades Wilderness Area on the Mark Twain National Forest in Taney County, Missouri.

- Two ozone monitors are located in Springfield, Missouri (#290770026 and #290770036), about 10 miles E of the park. By late 2001, information will be available regarding the need to install an ozone monitor in the park. In addition, the risk to sensitive vegetation in the park from ozone concentrations will be known.

- Based on the park vascular plant list contained in NPSpecies, twelve species occur in the park that are known to be very sensitive to ozone and 8 species occur that are known to be slightly sensitive to ozone. A good choice for ozone injury surveys in the park is black cherry because the symptoms of ozone injury are well documented on this species. Milkweed species are also good indicators of ozone injury.

Nebraska 8-hour Ozone Design Values

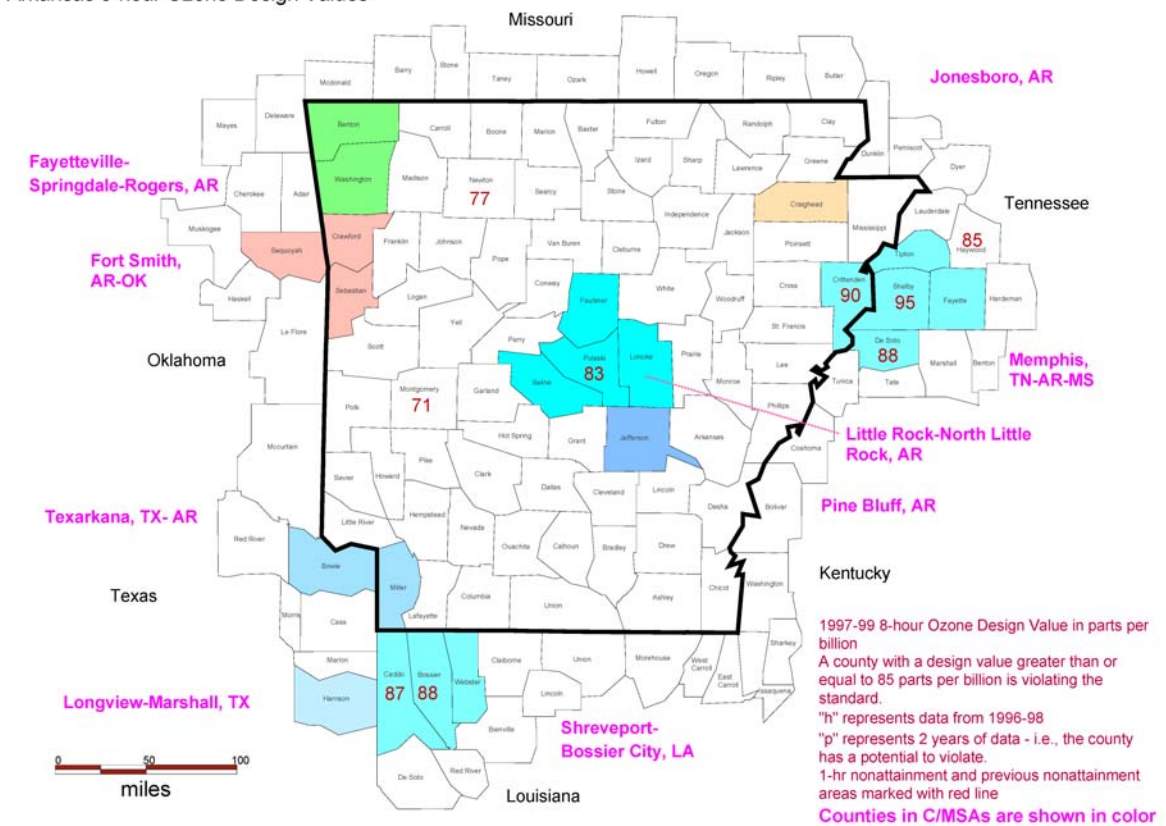


1997-99 8-hour Ozone Design Value in parts per billion
A county with a design value greater than or equal to 85
parts per billion is violating the standard.
"h" represents data from 1996-98
"p" represents 2 years of data - i.e., the county has a potential to violate.
1-hr nonattainment and previous nonattainment areas marked with red line

Counties in C/MSAs are shown in color

0 50 100
miles

Arkansas 8-hour Ozone Design Values



1997-99 8-hour Ozone Design Value in parts per billion
A county with a design value greater than or equal to 85 parts per billion is violating the standard.
"h" represents data from 1996-98
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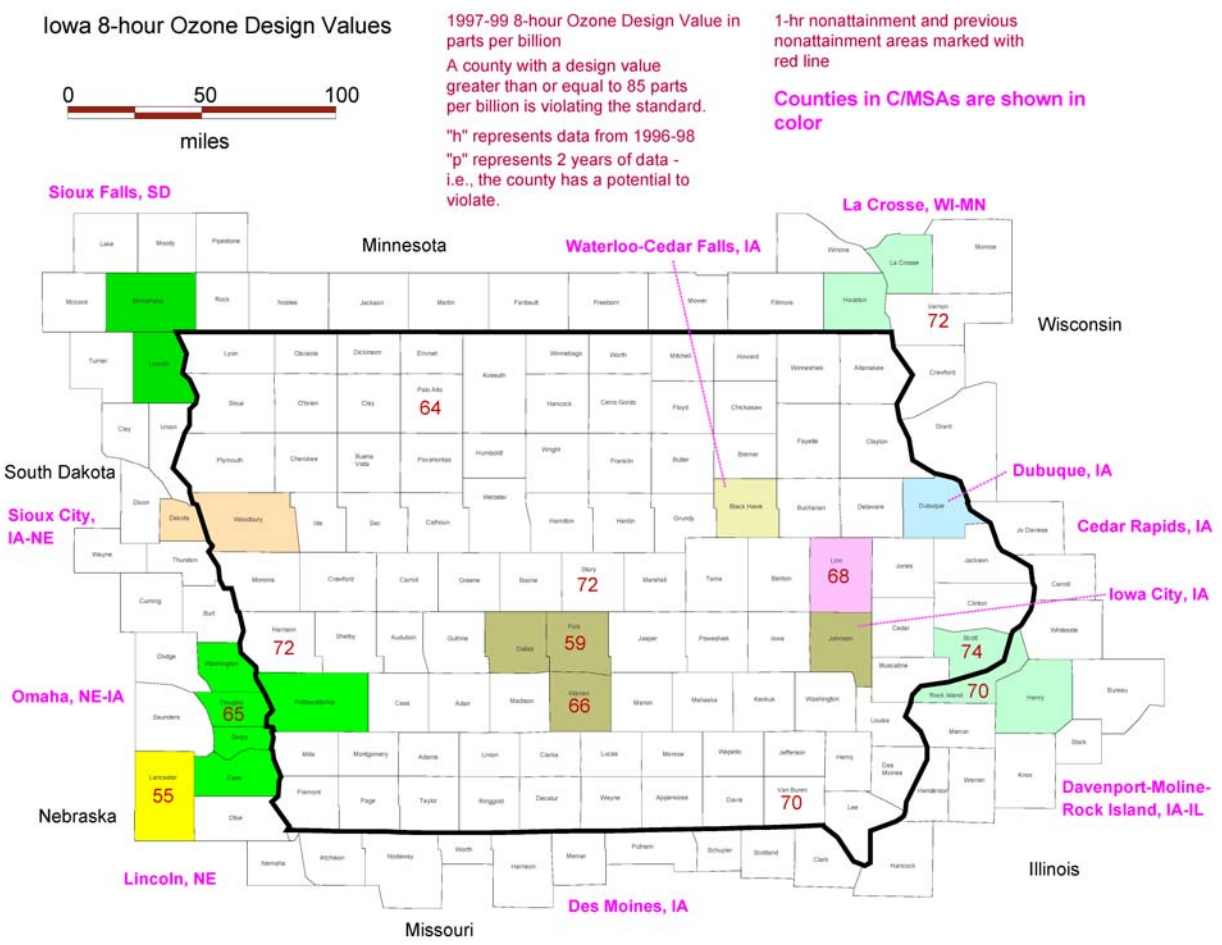
1-hr nonattainment and previous nonattainment areas marked with red line

Counties in C/MSAs are shown in color


Iowa 8-hour Ozone Design Values
0
50
100
miles
1997-99 8-hour Ozone Design Value in parts per billion
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"h" represents data from 1996-98
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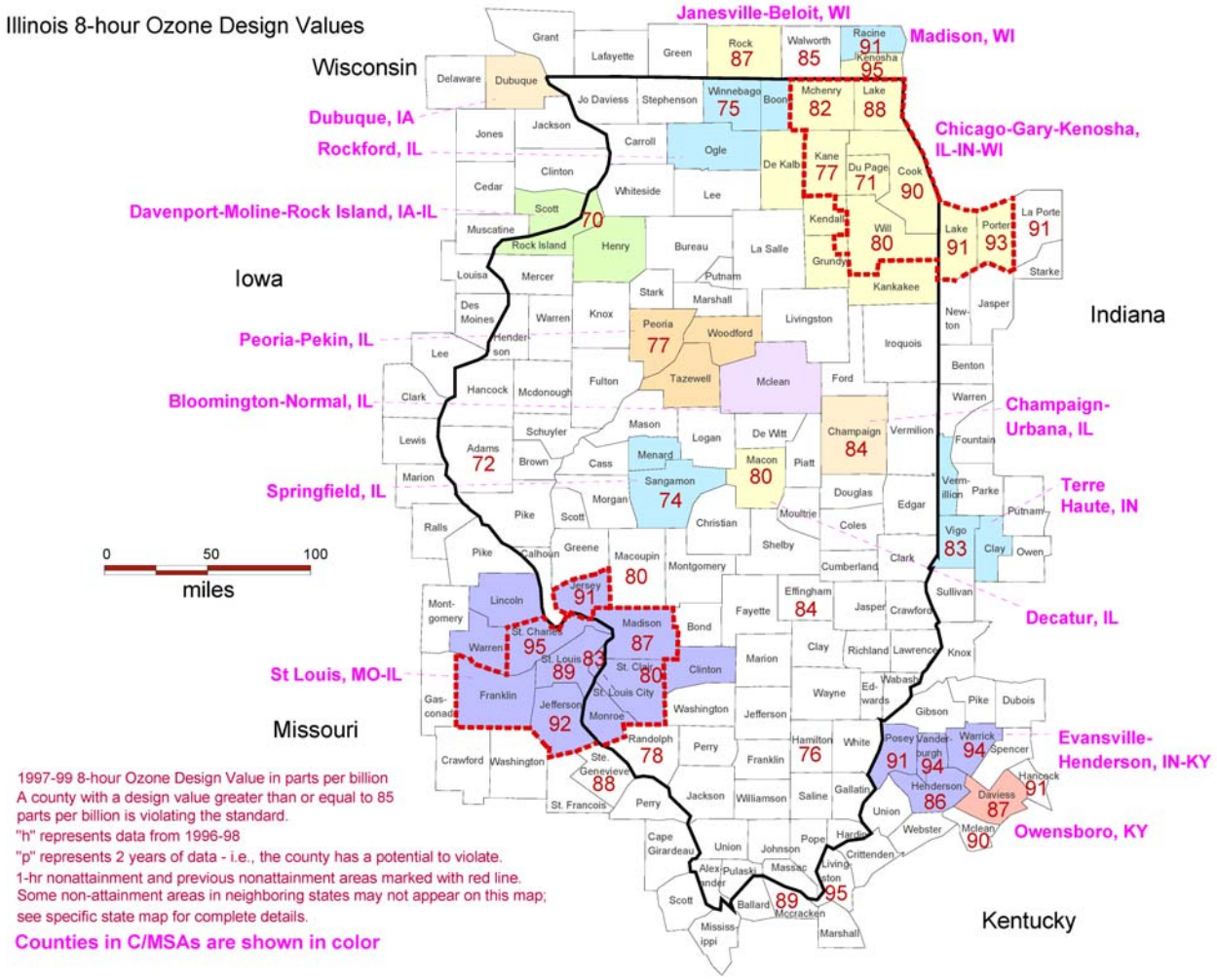
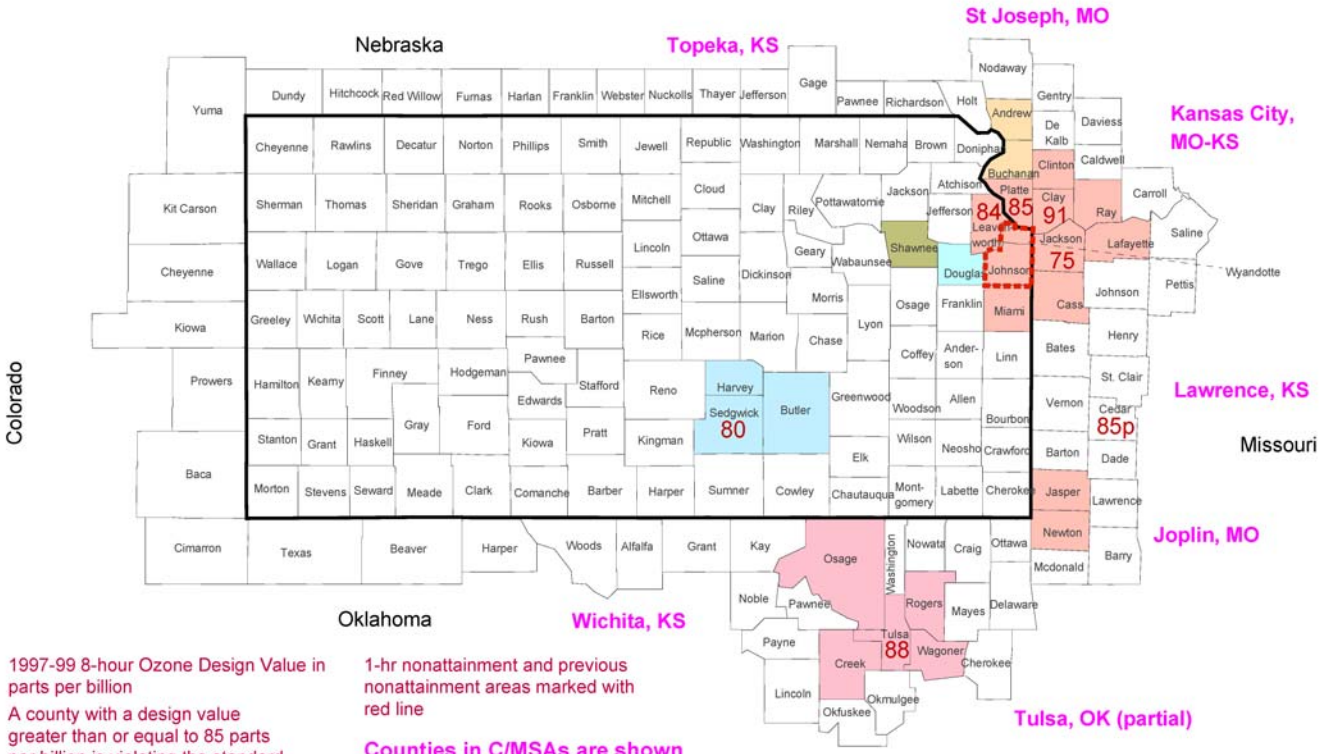
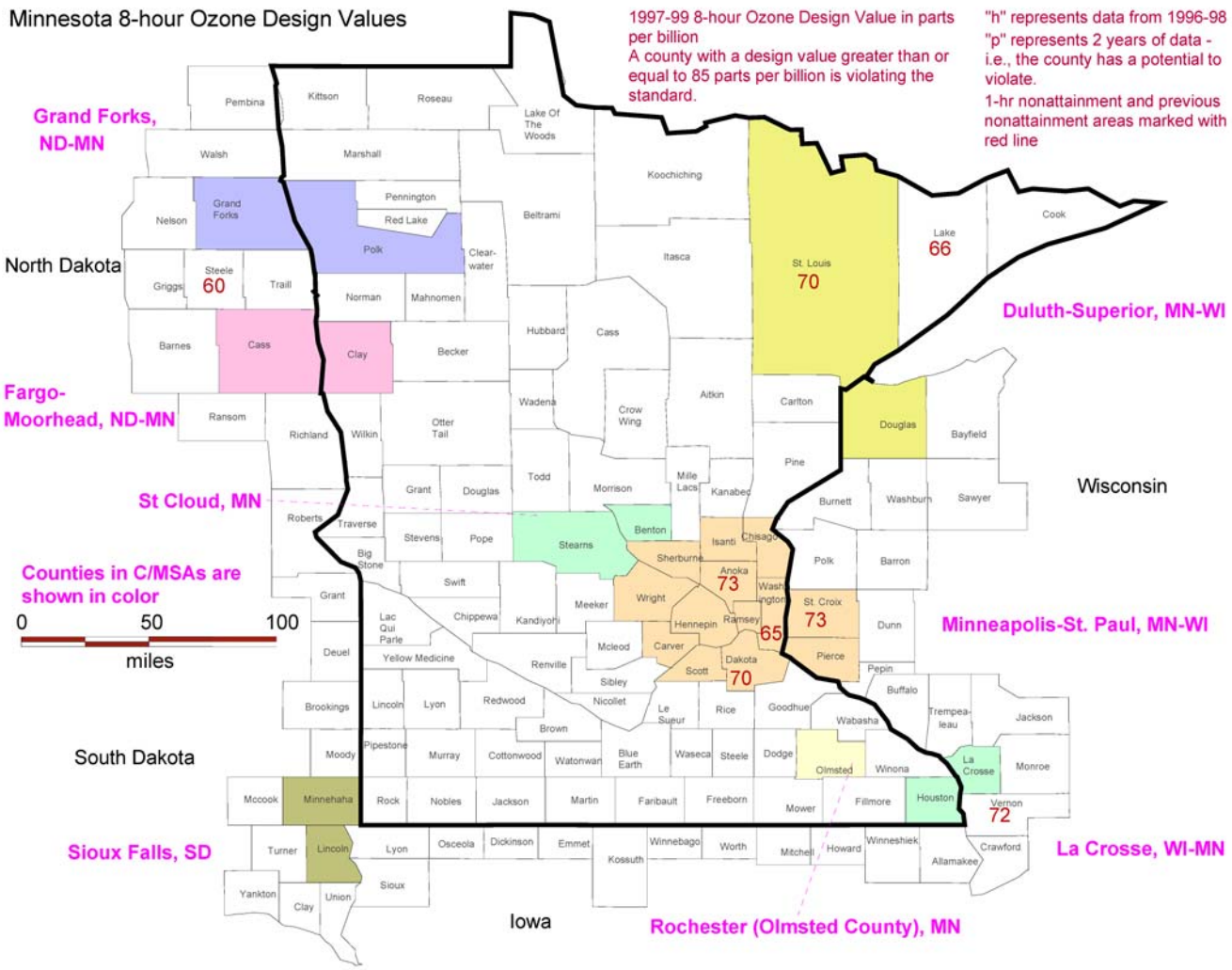
1-hr nonattainment and previous nonattainment areas marked with red line
Counties in C/MSAs are shown in color
Sioux Falls, SD
Minnesota
Waterloo-Cedar Falls, IA
La Crosse, WI-MN
Wisconsin
72
64
South Dakota
Dubuque, IA
Sioux City, IA-NE
Cedar Rapids, IA
68
72
Iowa City, IA
72
59
74
70
Omaha, NE-IA
65
66
Davenport-Moline-Rock Island, IA-IL
55
70
Nebraska
Illinois
Lincoln, NE
Des Moines, IA
Missouri


Illinois 8-hour Ozone Design Values
Janesville-Beloit, WI
Madison, WI
Wisconsin
Dubuque, IA
Rockford, IL
Chicago-Gary-Kenosha, IL-IN-WI
Davenport-Moline-Rock Island, IA-IL
Iowa
Indiana
Peoria-Pekin, IL
Bloomington-Normal, IL
Champaign-Urbana, IL
Springfield, IL
Terre Haute, IN
Decatur, IL
St Louis, MO-IL
Missouri
Evansville-Henderson, IN-KY
Owensboro, KY
Kentucky
0 50 100
miles
1997-99 8-hour Ozone Design Value in parts per billion
A county with a design value greater than or equal to 85 parts per billion is violating the standard.
"h" represents data from 1996-98
"p" represents 2 years of data - i.e., the county has a potential to violate.
1-hr nonattainment and previous nonattainment areas marked with red line.
Some non-attainment areas in neighboring states may not appear on this map; see specific state map for complete details.
Counties in C/MSAs are shown in color

Kansas 8-hour Ozone Design Values




Minnesota 8-hour Ozone Design Values
1997-99 8-hour Ozone Design Value in parts per billion
A county with a design value greater than or equal to 85 parts per billion is violating the standard.
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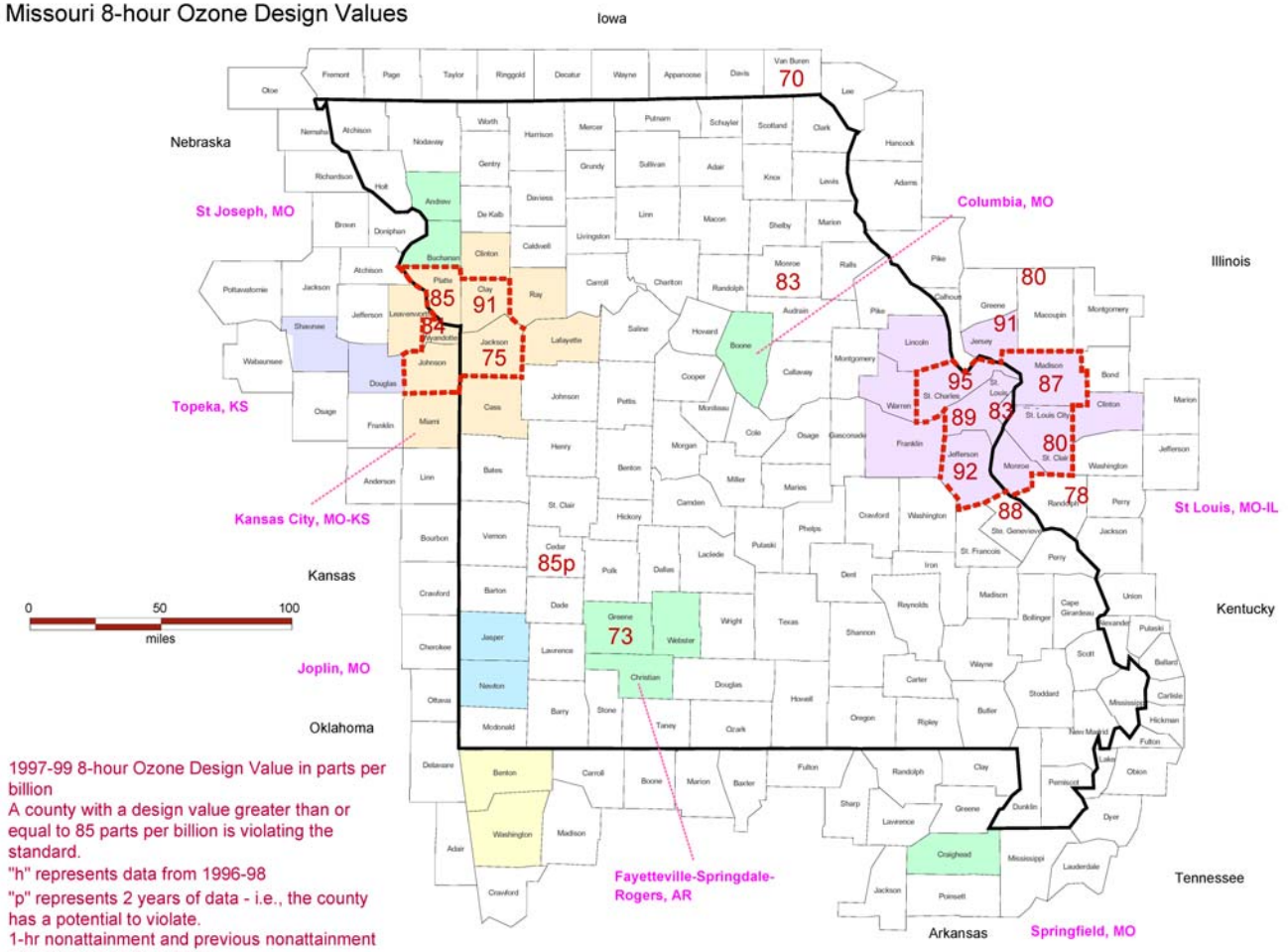
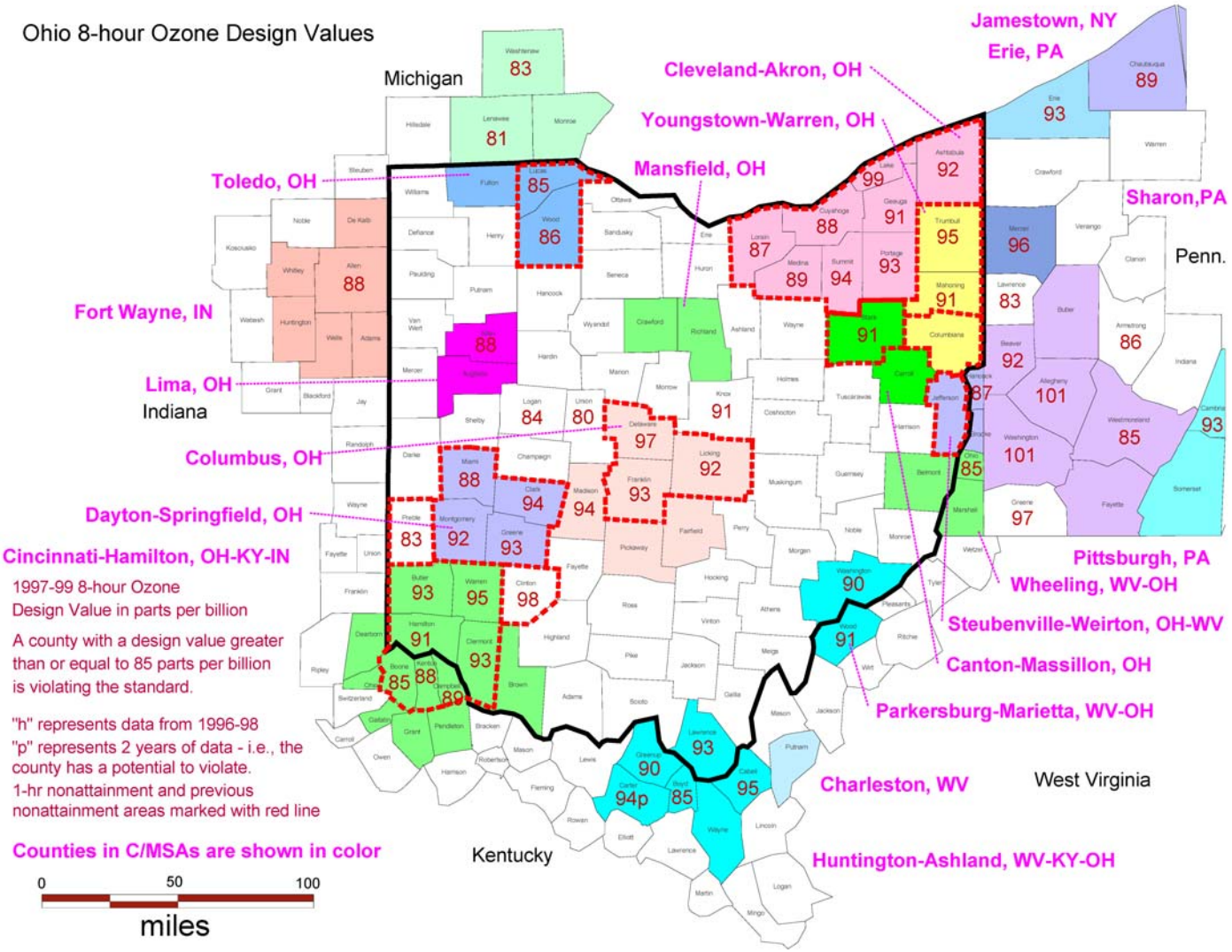
"p" represents 2 years of data - i.e., the county has a potential to violate.
1-hr nonattainment and previous nonattainment areas marked with red line
Grand Forks, ND-MN
Fargo-Moorhead, ND-MN
St Cloud, MN
Counties in C/MSAs are shown in color
0 50 100
miles
Sioux Falls, SD
Duluth-Superior, MN-WI
Minneapolis-St. Paul, MN-WI
La Crosse, WI-MN
Rochester (Olmsted County), MN
North Dakota
South Dakota
Wisconsin
Iowa
Steele 60
St. Louis 70
Lake 66
Anoka 73
Hennepin 65
Dakota 70
St. Croix 73
Olmsted 72
Pembina
Kittson
Roseau
Lake Of The Woods
Walsh
Marshall
Koochiching
Cook
Grand Forks
Pennington
Red Lake
Polk
Nelson
Beltrami
Clear-water
Itasca
Griggs
Traill
Norman
Mahnomen
Hubbard
Cass
Barnes
Cass
Clay
Becker
Wadena
Crow Wing
Aitkin
Carlton
Douglas
Bayfield
Ransom
Richland
Wilkin
Otter Tail
Todd
Morrison
Mille Lacs
Kanabec
Pine
Burnett
Washburn
Sawyer
Grant
Douglas
Roberts
Traverse
Stevens
Pope
Stearns
Benton
Isanti
Chisago
Sherburne
Polk
Barron
Big Stone
Swift
Grant
Meeker
Wright
Washington
Chippewa
Kandiyohi
Ramsey
Dunn
Lac Qui Parle
Mcleod
Carver
Pierce
Deuel
Yellow Medicine
Renville
Scott
Pepin
Sibley
Buffalo
Brookings
Lincoln
Lyon
Redwood
Nicollet
Le Sueur
Rice
Goodhue
Trempea-leau
Jackson
Brown
Wabasha
Moody
Pipestone
Murray
Cottonwood
Watonwan
Blue Earth
Waseca
Steele
Dodge
Olmsted
Winona
La Crosse
Monroe
Mccook
Minnehaha
Rock
Nobles
Jackson
Martin
Faribault
Freeborn
Mower
Fillmore
Houston
Vernon
Turner
Lincoln
Lyon
Osceola
Dickinson
Emmet
Winnebago
Worth
Mitchell
Howard
Winneshiek
Crawford
Allamakee
Kossuth
Yankton
Clay
Union
Sioux

Missouri 8-hour Ozone Design Values



1997-99 8-hour Ozone Design Value in parts per billion
A county with a design value greater than or equal to 85 parts per billion is violating the standard.
"h" represents data from 1996-98
"p" represents 2 years of data - i.e., the county has a potential to violate.
1-hr nonattainment and previous nonattainment areas marked with red line

Counties in C/MSAs are shown in color


Ohio 8-hour Ozone Design Values
Michigan
Indiana
Kentucky
West Virginia
Penn.
Jamestown, NY
Erie, PA
Cleveland-Akron, OH
Youngstown-Warren, OH
Mansfield, OH
Toledo, OH
Fort Wayne, IN
Lima, OH
Columbus, OH
Dayton-Springfield, OH
Cincinnati-Hamilton, OH-KY-IN
Sharon,PA
Pittsburgh, PA
Wheeling, WV-OH
Steubenville-Weirton, OH-WV
Canton-Massillon, OH
Parkersburg-Marietta, WV-OH
Charleston, WV
Huntington-Ashland, WV-KY-OH
1997-99 8-hour Ozone
Design Value in parts per billion
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1-hr nonattainment and previous nonattainment areas marked with red line
Counties in C/MSAs are shown in color
0
50
100
miles